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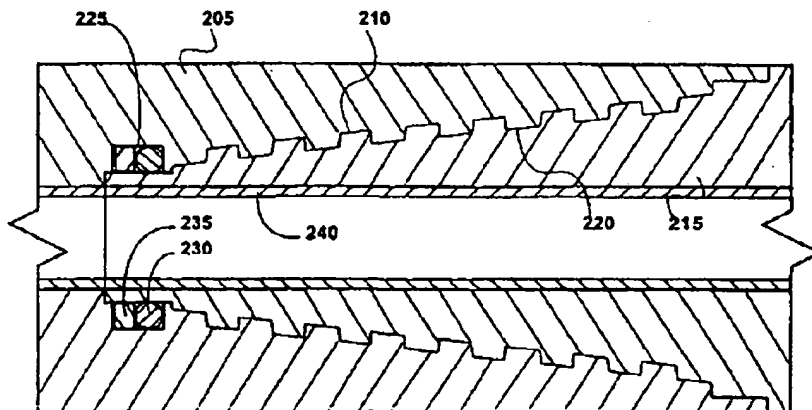
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(54) Title: LUBRICANT COATING FOR EXPANDABLE TUBULAR MEMBERS



(57) Abstract: A lubricant coating (240) for expandable tubulars (215). The interior surfaces of the expandable tubulars are coated with the lubricant coating (240). The expandable tubulars (215) are then placed within a preexisting structure (205). The expandable tubulars are then radially expanded into contact with the preexisting structure.



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LUBRICANT COATING FOR EXPANDABLE TUBULAR MEMBERS

Background of the Invention

5 This invention relates generally to coupling at least one tubular member to a preexisting structure. The at least one tubular member may be for example, a wellbore casing, an underground pipe or a structural support. For convenience, the invention will be described hereinafter with reference to wellbore casings.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. 10 The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are 15 provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig 20 time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of 25 the existing procedures for forming wellbores. It has been proposed to form wellbore casings using expandable tubular members, and the present invention is particularly directed to improving methods and apparatus using at least one expandable tubular member.

Summary of the Invention

30 According to a first aspect of the present invention, a method of coupling an expandable tubular assembly including at least one tubular member to a preexisting

Fig. 2 is cross sectional illustration of a plurality of tubular members including in internal coating of a lubricant.

Fig. 3 is a fragmentary cross sectional illustration of the radial expansion of the tubular members of Fig. 2 into contact with a preexisting structure; and

5 Fig. 4 is a flow chart illustrating an alternative preferred embodiment of a method for coupling a plurality of tubular members to a preexisting structure.

Detailed Description

A method and apparatus for coupling tubular members to a preexisting structure is provided. The internal surfaces of the tubular members are coated with a lubricant. The
10 tubular members are then radially expanded into contact with a preexisting structure. In several alternative embodiments, the method and apparatus are used to form and/or repair a wellbore casing, a pipeline, or a structural support.

In Fig. 1, a preferred embodiment of a method 100 for forming and/or repairing a wellbore casing, pipeline, or structural support includes the steps of: (1) providing one or
15 more tubular members in step 105; (2) applying a lubricant coating to the interior walls of the tubular members in step 110; (3) coupling the first and second tubular members in step 115; and (4) radially expanding the tubular members into contact with the preexisting structure in step 120.

As illustrated in Fig. 2, in a preferred embodiment, in step 105, a first tubular
20 member 205 having a first threaded portion 210 and a second tubular member 215 having a second threaded portion 220 are provided. The first and second tubular members, 205 and 215, may be any number of conventional commercially available tubular members. In a preferred embodiment, the first tubular member 205 includes a recess 225 containing a sealing member 230 and a retaining ring 235. In a preferred embodiment, the first and
25 second tubular members, 205 and 210, are further provided substantially as disclosed in US Patent No. 6,497,289 and Australian Patent No. 767364; Australian Patent No. 770008; Australian Patent No. 771884; US Patent No. 6,328,113; US Patent No. 6,640,903; US Patent No. 6,575,240; US Patent No. 6,557,640 and Australian Patent No. 773168; US Patent No. 6,604,763 and filed as AU 37920/00; Australian Patent No. 776580; US Patent
30 No. 6,564,875; US Patent No. 6,568,471.

In a preferred embodiment, in step 110, a coating 240 of a lubricant is applied to

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tubular members during storage and transport.

In a preferred embodiment, the coating 240 of lubricant includes sodium, calcium, and/or zinc stearates; and/or zinc and/or manganese phosphates; and/or C-Lube-10; and/or C-Phos-58-M; and/or C-Phos-58-R; and/or polytetrafluoroethylene (PTFE); and/or molybdenum disulfide; and/or metallic soaps (stearates, oleates, etc...) in order to optimally provide a coating of lubricant. In a preferred embodiment, the coating 240 of lubricant provides a sliding coefficient of friction less than about 0.20 in order to optimally reduce the force required to radially expand the tubular members, 205 and 215, using an expansion cone.

10 In a preferred embodiment, in step 115, the first and second tubular members, 205 and 215, are coupled. The first and second tubular members, 205 and 215, may be coupled using a threaded connection, or, alternatively, the first and second tubular members, 205 and 215, may be coupled by welding or brazing. In a preferred embodiment, the first and second tubular members, 205 and 215, are coupled substantially as disclosed in the above
15 US and Australian patent specifications.

As illustrated in Fig. 3, in steps 120, the first and second tubular members 205 and 215 are then positioned within a preexisting structure 505, and radially expanded into contact with the interior walls of the preexisting structure 505 using an expansion cone 510. The tubular members 205 and 215 may be radially expanded into intimate contact
20 with the interior walls of the preexisting structure 505, for example, by: (1) pushing or pulling the expansion cone 510 through the interior of the tubular members 205 and 215; and/or (2) pressurizing the region within the tubular members 205 and 215 behind the expansion cone 510 with a fluid. In a preferred embodiment, one or more sealing members 515 are further provided on the outer surface of the tubular members 205 and 215, in order
25 to optimally seal the interface between the radially expanded tubular members 205 and 215 and the interior walls of the preexisting structure 505.

In a preferred embodiment, the radial expansion of the tubular members 205 and 215 into contact with the interior walls of the preexisting structure 505 is performed substantially as disclosed in one or more of the above US and Australian Patent
30 specification.

As illustrated in Fig. 4, an alternative embodiment of a method 400 for forming and/or repairing a wellbore casing, pipeline, or structural support includes the steps of: (1)

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providing one or more tubular members in step 405; (2) applying a coating including a first part of a lubricant to the interior walls of the tubular members in step 410; (3) coupling the first and second tubular members in step 415; and (4) radially expanding the tubular members into contact with the preexisting structure while also circulating fluidic materials into contact with the interior walls of the tubular members having a second part of the lubricant in step 420.

In a preferred embodiment, in step 410, a coating including a first part of a lubricant is applied to the interior walls of the tubular members, 205 and 215.

In a preferred embodiment, the first part of the lubricant forms a first part of a metallic soap. In an preferred embodiment, the first part of the lubricant coating includes zinc phosphate.

In a preferred embodiment, in step 420, a second part of the lubricant is circulated within a fluidic carrier into contact with the coating of the first part of the lubricant applied to the interior walls of the tubular members, 205 and 215. In a preferred embodiment, the first and second parts react to form a lubricating layer between the interior walls of the tubular members, 205 and 215, and the exterior surface of the expansion cone. In this manner, a lubricating layer is provided in exact concentration, exactly when and where it is needed. Furthermore, because the second part of the lubricant is circulated in a carrier fluid, the dynamic interface between the interior surfaces of the tubular members, 205 and 215, and the exterior surface of the expansion cone 510 is also preferably provided with hydrodynamic lubrication. In a preferred embodiment, the first and second parts of the lubricant react to form a metallic soap. In a preferred embodiment, the second part of the lubricant is sodium, calcium and/or zinc stearate.

In several experimental exemplary embodiments of the methods 100 and 400, the following observations were made regarding lubricant coatings for expandable tubular members:

- (1) boundary lubrication with a lubricant coating having high adhesion (high film/shear strength) to the expandable tubular is the single most important lubricant/lubrication process in the radial expansion process;
- (2) hydrodynamic lubrication plays a secondary role in the lubrication process;
- (3) expandable tubular lubricant coating offers the more reliable and more effective form of boundary lubrication;

- Extremc pressure lubrication is preferably provided by: (1) liquid extreme pressure lubricants added to the fluid (e.g., drilling fluid, etc) in contact with the internal surface of the expandable tubular during the radial expansion process, and/or (2) solid lubricants added to, or contained within, the fluid in contact with the internal surface of the

Liquid extreme pressure lubricant additives preferably work by chemically adhering to or being strongly attracted to the surface of the expandable tubular to be expanded. These types of liquid extreme pressure lubricant additives preferably form a 'film' on the surface of the expandable tubular member. The adhesive strength of this film is preferably greater than the shearing force along the internal surface of the expandable tubular member during the radial expansion process. This adhesive force is referred to as film strength. The film strength can be increased by increasing the viscosity of the fluid. Common viscosifiers, such as polymeric additives, are preferably added to the fluid in contact with the internal surface of the expandable tubular member during the radial expansion process to increase lubrication. In a preferred embodiment, these liquid extreme pressure lubricant additives include one or more of the following: polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives such as, for example, hydroxyethylcellulose, carboxymethylhydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol/vinyl acetate copolymers, polyvinyl pyrrolidone and copolymers including polyolefins, latexes such as, for example, styrene butadiene latex, urethane latexes, styrene-maleic anhydride copolymers, viscosity index improvers for motor oils such as polyacrylate esters, block copolymers including styrene, isoprene butadiene and ethylene, ethylene acrylic acid copolymers.

In a preferred embodiment, the solid lubricants are applied directly to the expandable tubulars as coatings. The coating of the solid lubricant preferably includes a

20 In a preferred embodiment, solid lubricant coatings use binders that provide low friction that is enhanced under extreme pressure conditions by the presence of the solid lubricant. Preferred solid lubricant coatings includes one or more of the following: graphite, molybdenum disulfide, silicone polymers and polytetrafluoroethylene (PTFE). In a preferred embodiment, blends of these materials are used since each material has

25 lubrication characteristics that optimally work at different stages in the radial expansion process. In a preferred embodiment, a solid, dry film lubricant coating for the internal surface of the expandable tubular includes: (1) 1 to 90 percent solids by volume; (2) more preferably, 5 to 70 percent solids by volume; and (3) most preferably, 15 to 50 percent solids by volume. In a preferred embodiment, the solid lubricants include: (1) 5 to 80

30 percent graphite; (2) 5 to 80 percent molybdenum disulfide; (3) 1 to 40 percent PTFE; and (4) 1 to 40 percent silicone polymers.

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In several exemplary embodiment, the liquid lubricant additives include one or more of the following: (1) esters including: (a) organic acid esters (preferably fatty acid esters) such as, for example, trimethylol propane, isopropyl, penterithritol, n-butyl, etc.; (b) glycerol tri (acetoxystearate) and N, N' ethylene bis 12 hydroxystearate and octyl 5 hydroxystearate; (c) phosphate and phosphite such as, for example, butylated triphenyl phosphate and isodiphenyl phosphate; (2) sulfurized natural and synthetic oils; (3) alkanolamides such as, for example, coco diethanolamide; (4) amines and amine salts; (5) olefins and polyolefins; (6) C-8 to C-18 linear alcohols and derivatives containing or consisting of esters, amines, carboxylates, etc.; (7) overbased sulfonates such as, for 10 example, calcium sulfonate, sodium sulfonate, magnesium sulfonate; (8) polyethylene glycols; (9) silicones and siloxanes such as, for example, dimethylpolysiloxanes and fluorosilicone derivatives; (10) dinonyl phenols; and (11) ethylene oxide/propylene oxide block copolymers.

Where a liquid lubricant is injected into contact with the expandable tubular 15 assembly, the liquid lubricant material may be selected from: polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives, hydroxyethylcellulose, carboxymethyl hydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol/vinyl acetate copolymers, polyvinyl pyrrolidone, copolymers including polyolefins, latexes, styrene butadiene latex, urethane latexes, styrene-maleic 20 anhydride copolymers, viscosity index improvers for motor oils, polyacrylate esters, block copolymers including styrene, isoprene butadiene and ethylene, ethylene acrylic acid copolymers, esters, organic acid esters, trimethylol propane, isopropyl, penterithritol, n-butyl, glycerol triacetoxystearate, N,N' ethylene bis 12 hydroxystearate, octyl hydroxystearate, phosphate, phosphite, butylated triphenyl phosphate, isodiphenyl 25 phosphate, sulfurized natural oils, synthetic oils, alkanolamides, coco diethanolamide, amines, amine salts, olefins, polyolefins, C-8 to C-18 linear alcohols and derivatives including esters, amines, carboxylates, overbased sulfonates, calcium sulfonate, sodium sulfonate, magnesium sulfonate, polyethylene glycols, silicones, siloxanes, dimethylpolysiloxanes, fluorosilicone derivatives, dinonyl phenols, and ethylene 30 oxide/propylene oxide block copolymers. In a preferred embodiment, the injected lubricant material includes a solid lubricant material. In a preferred embodiment, the solid lubricant material is selected from the group consisting of: graphite, molybdenum

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manganese phosphate, C-Lube-10, C-PHOS-58-M, and C-PHOS-58-R. In a preferred embodiment, the lubricant provides a sliding friction coefficient of less than about 0.20. In a preferred embodiment, the first part of the lubricant is chemically bonded to the interior surfaces of the tubular members. In a preferred embodiment, the first part of the lubricant is mechanically bonded to the interior surfaces of the tubular members. In a preferred embodiment, the first part of the lubricant is adhesively bonded to the interior surface of the tubular members. In a preferred embodiment, the apparatus further includes combining the first and second parts of the lubricant to generate the lubricant.

Although this detailed description has shown and described illustrative
10 embodiments of the invention, this description contemplates a wide range of modifications,
changes, and substitutions. In some instances, one may employ some features of the
present invention without a corresponding use of the other features. Accordingly, it is
appropriate that readers should construe the appended claims broadly, and in a manner
consistent with the scope of the invention.

15 The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that that prior art forms part of the common general knowledge in Australia.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

PROPRIETARY/CONFIDENTIAL INFORMATION

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of coupling an expandable tubular assembly including at least one tubular member to a preexisting structure, comprising:
 - 5 coating the interior surface of the at least one tubular member with a lubricant;
 - positioning the coated at least one tubular member within a preexisting structure; and
 - radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.
- 10 2. A method of coupling an expandable tubular assembly including at least one tubular member to a preexisting structure, comprising:
 - coating the interior surface of the at least one tubular member with a first part of a lubricant;
 - 15 positioning the coated at least one tubular member within a preexisting structure;
 - circulating a fluidic material including a second part of the lubricant into contact with the coating of the first part of the lubricant; and
 - radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.
- 20 3. The method of claim 1 or 2, wherein the at least one tubular member comprises a wellbore casing.
4. The method of claim 1 or 2, wherein the at least one tubular member comprises an underground pipe.
5. The method of claim 1 or 2, wherein the at least one tubular member comprises a structural support.
- 25 6. The method of claim 1, wherein the coating of lubricant is chemically bonded to the interior surface of the at least one tubular member.
7. The method of claim 1, wherein the coating of lubricant is mechanically bonded to the interior surface of the at least one tubular member.

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8. The method of claim 1, wherein the coating of lubricant is adhesively bonded to the interior surface of the at least one tubular member.
9. The method of claim 1, wherein the coating of lubricant includes:
a primer coating coupled to the interior surface of the at least one tubular member;
and
a coating of an antifriction paste coupled to the primer.
10. The method of claim 1, wherein the coating of lubricant includes, in parts by weight:
40-80 epoxy resin, 15-30 molybdenum disulfide, 10-15 graphite, 5-10 aluminum, 5-10 copper, 8-15 aluminosilicate, and 5-10 polyethylenepolyamine.
11. The method of claim 1 or 2, wherein the lubricant comprises a metallic soap.
12. The method of claim 1 or 2, wherein the lubricant comprises zinc phosphate.
13. The method of claim 1 or 2, wherein the lubricant provides a coefficient of dynamic friction of between about 0.08 to 0.1.
14. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
sodium stearates, calcium stearates, zinc stearates, zinc phosphate, manganese phosphate, C-Lube-10, C-Phos-58-M, C-Phos-58-R, polytetrafluoroethylene, molybdenum disulfide, and metallic soaps.
15. The method of claim 1 or 2, wherein the lubricant provides a sliding coefficient of friction less than about 0.20.
16. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives, hydroxyethylcellulose, carboxymethyl hydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol acetate copolymers, polyvinyl vinyl acetate copolymers, polyvinyl pyrrolidone and copolymers including polyolefins, latexes, styrene butadiene latex, urethane

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latexes, styrene-maleic anhydride copolymers, viscosity index improvers for motor oils, polyacrylate esters, block copolymers including styrene, block copolymers including isoprene butadiene, block copolymers including ethylene, and ethylene acrylic acid copolymers.

- 5 17. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
graphite, molybdenum disulfide, lead powder, antimony oxide, poly
tetrafluoroethylene, and silicone polymers.
18. The method of claim 1, wherein the coating of lubricant comprises:
a solid lubricant; and
10 a binder.
19. The method of claim 18, wherein the binder is selected from:
epoxy, acrylic, urea-formaldehyde, melamine formaldehyde, furan based resin,
acetone formaldehyde, phenolic, alkyd resins, and silicone modified alkyd resin.
20. The method of claim 18, wherein the binder is selected from:
15 vinyl acetate, vinyl chloride, maleic anhydride, maleic acid, ethylene-acrylic acid
copolymers, ethylene-methacrylic acid copolymers, and ethylene-vinyl acetate
copolymers.
21. The method of claim 1 or 2, wherein the lubricant comprises a suspension of
particles in a carrier solvent.
- 20 22. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
manganese phosphate, zinc phosphate, and iron phosphate.
23. The method of claim 1 or 2, wherein the lubricant comprises:
about 1 to 90 percent solids by volume.
24. The method of claim 23, wherein the lubricant comprises:
25 about 5 to 70 percent solids by volume.
25. The method of claim 24, wherein the lubricant comprises:
about 15 to 50 percent solids by volume.

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26. The method of claim 1 or 2, wherein the lubricant comprises:
 about 5 to 80 percent graphite;
 about 5 to 80 percent molybdenum disulfide;
 about 1 to 40 percent PTFE; and
 5 about 1 to 40 percent silicone polymers.
27. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
 ester;
 sulfurized oil;
 alkanolamides;
 10 amine;
 amine salt;
 olefin;
 polyolefins;
 C-8 to C-18 linear alcohol;
 15 derivative of C-8 to C-18 linear alcohol including ester;
 derivative of C-8 to C-18 linear alcohol including amine;
 derivative of C-8 to C-18 linear alcohol including carboxylate;
 sulfonate;
 polyethylene glycol;
 20 silicone;
 siloxane;
 dinonyl phenol;
 ethylene oxide block copolymer; and
 propylene oxide block copolymer.
- 25 28. Apparatus, comprising:
 a preexisting structure; and
 at least one tubular member coupled to the preexisting structure by the process of:
 coating the interior surface of the at least one tubular member with a lubricant;
 positioning the coated at least one tubular member within a preexisting structure;
 30 and
 radially expanding the coated at least one tubular member into contact with the

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preexisting structure using an expansion cone that engages the coating.

29. Apparatus, comprising:
 a preexisting structure; and
 at least one tubular member coupled to the preexisting structure by the process of:
 5 coating the interior surface of the at least one tubular member with a first part of a
 lubricant;
 positioning the at least one tubular member within a preexisting structure;
 circulating a fluidic material having a second part of the lubricant into contact with
 the coating of the first part of the lubricant; and
 10 radially expanding the coated at least one tubular member into contact with the
 preexisting structure using an expansion cone that engages the coating.
30. The apparatus of claim 28 or 29, wherein the at least one tubular member
 comprises a wellbore casing.
31. The apparatus of claim 28 or 29, wherein the at least one tubular member
 15 comprises an underground pipe.
32. The apparatus of claim 28 or 29, wherein the at least one tubular member
 comprises a structural support.
33. The apparatus of claim 28, wherein the coating of lubricant is chemically bonded to
 the interior surface of the at least one tubular member.
- 20 34. The apparatus of claim 28, wherein the coating of lubricant is mechanically bonded
 to the interior surface of the at least one tubular member.
35. The apparatus of claim 28, wherein the coating of lubricant is adhesively bonded to
 the interior surface of the at least one tubular member.
- 25 36. The apparatus of claim 28, wherein the coating of lubricant includes:
 a primer coating coupled to the interior surface of the at least one tubular member;
 and
 a coating of an antifriction paste coupled to the primer.

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37. The apparatus of claim 28, wherein the coating of lubricant includes, in parts by weight:
40-80 epoxy resin, 15-30 molybdenum disulfide, 10-15 graphite, 5-10 aluminum, 5-10 copper, 8-15 aluminosilicate, and 5-10 polyethylenepolyamine.
38. The apparatus of claim 28 or 29, wherein the lubricant comprises a metallic soap.
39. The apparatus of claim 28 or 29, wherein the lubricant comprises zinc phosphate.
40. The apparatus of claim 28 or 29, wherein the lubricant provides a coefficient of dynamic friction of between about 0.08 to 0.1.
41. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of:
sodium stearates, calcium stearates, zinc stearates, zinc phosphate, manganese phosphate, C-Lube-10, C-Phos-58-M, C-Phos-58-R, polytetrafluoroethylene, molybdenum disulfide, and metallic soaps.
42. The apparatus of claim 28 or 29, wherein the lubricant provides a sliding coefficient of friction less than about 0.20.
43. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of:
polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives, hydroxyethylcellulose, carboxymethyl hydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol acetate copolymers, polyvinyl vinyl acetate copolymers, polyvinyl pyrrolidone and copolymers including polyolefins, latexes, styrene butadiene latex, urethane latexes, styrene-maleic anhydride copolymers, viscosity index improvers for motor oils, polyacrylate esters, block copolymers including styrene, block copolymers including isoprene butadiene, block copolymers including ethylene, and ethylene acrylic acid copolymers.
44. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of:
graphite, molybdenum disulfide, lead powder, antimony oxide, polytetrafluoroethylene, and silicone polymers.

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45. The apparatus of claim 28, wherein the coating of lubricant comprises:
a solid lubricant; and
a binder.
46. The apparatus of claim 45, wherein the binder is selected from:
epoxy, acrylic, urea-formaldehyde, melamine formaldehyde, furan based resin,
acetone formaldehyde, phenolic, alkyd resins, and silicone modified alkyd resin.
47. The apparatus of claim 45, wherein the binder is selected from:
vinyl acetate, vinyl chloride, maleic anhydride, maleic acid, ethylene-acrylic acid
copolymers, ethylene-methacrylic acid copolymers, and ethylene-vinyl acetate
copolymers.
48. The apparatus of claim 28 or 29, wherein the lubricant comprises a suspension of
particles in a carrier solvent.
49. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of:
manganese phosphate, zinc phosphate, and iron phosphate.
50. The apparatus of claim 28 or 29, wherein the lubricant comprises:
about 1 to 90 percent solids by volume.
51. The apparatus of claim 50, wherein the lubricant comprises:
about 5 to 70 percent solids by volume.
52. The apparatus of claim 51, wherein the lubricant comprises:
about 15 to 50 percent solids by volume.
53. The apparatus of claim 28 or 29, wherein the lubricant comprises:
about 5 to 80 percent graphite;
about 5 to 80 percent molybdenum disulfide;
about 1 to 40 percent PTFE; and
about 1 to 40 percent silicone polymers.
54. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of
the following:

- ester;
 sulfurized oil;
 alkanolamides;
 amine;
 5 amine salt;
 olefin;
 polyolefins;
 C-8 to C-18 linear alcohol;
 derivative of C-8 to C-18 linear alcohol including ester;
 10 derivative of C-8 to C-18 linear alcohol including amine;
 derivative of C-8 to C-18 linear alcohol including carboxylate;
 sulfonate;
 polyethylene glycol;
 silicone;
 15 siloxane;
 dinonyl phenol;
 ethylene oxide block copolymer; and
 propylene oxide block copolymer.
- 20 55. A method of coupling an expandable tubular assembly including at least one
 tubular member to a preexisting structure, the method being according to claim 1 or
 2, substantially as hereinbefore described with reference to the accompanying
 drawings.
- 25 56. Apparatus according to claim 28 or 29, substantially as hereinbefore described with
 reference to the accompanying drawings.

DATED this 20th day of July, 2005

Shell Internationale Research Maatschappij B.V.

By DAVIES COLLISON CAVE

30 Patent Attorneys for the Applicant

1/4

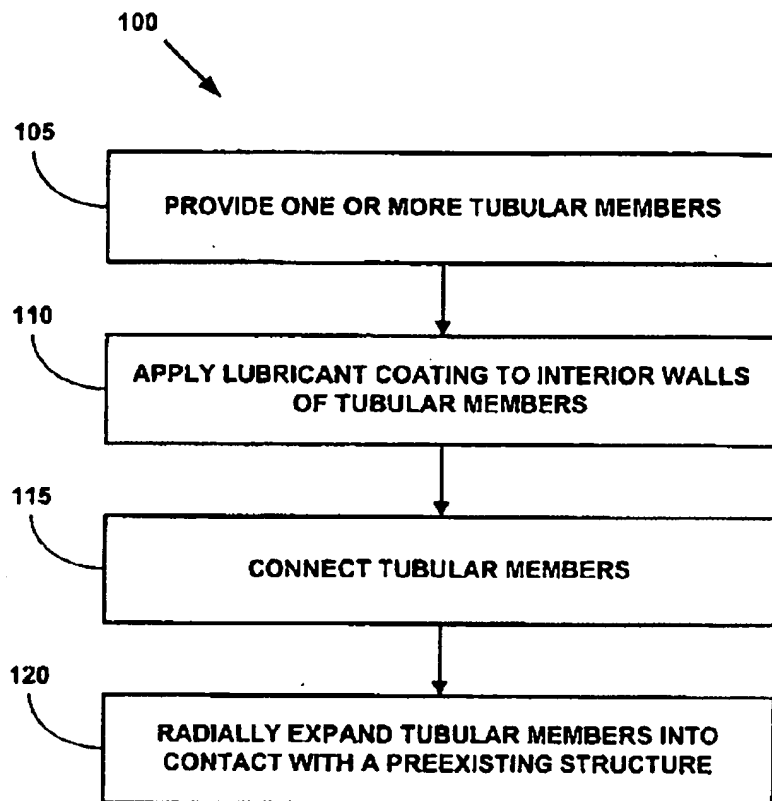


FIGURE 1

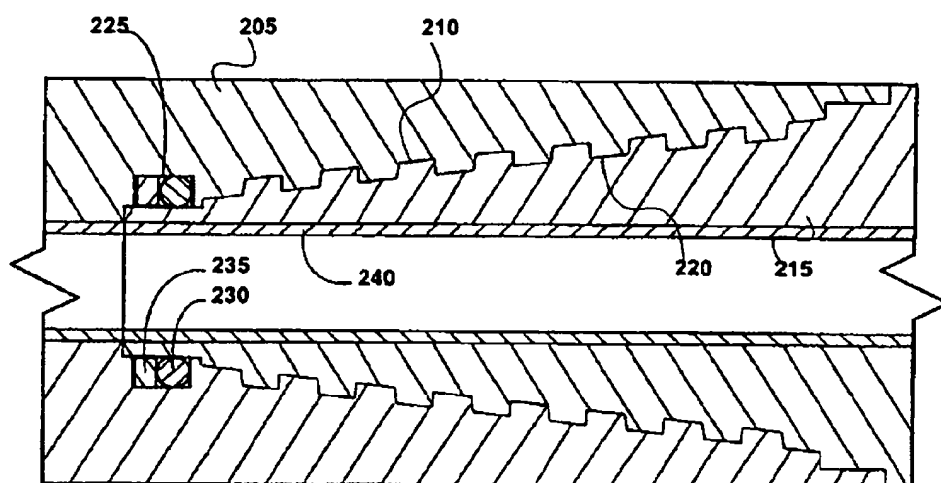


FIGURE 2

3/4

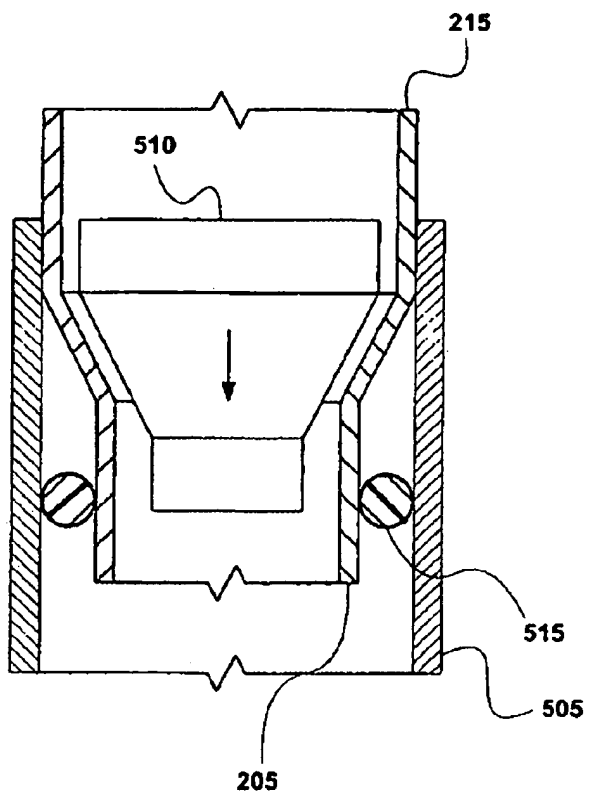


FIGURE 3

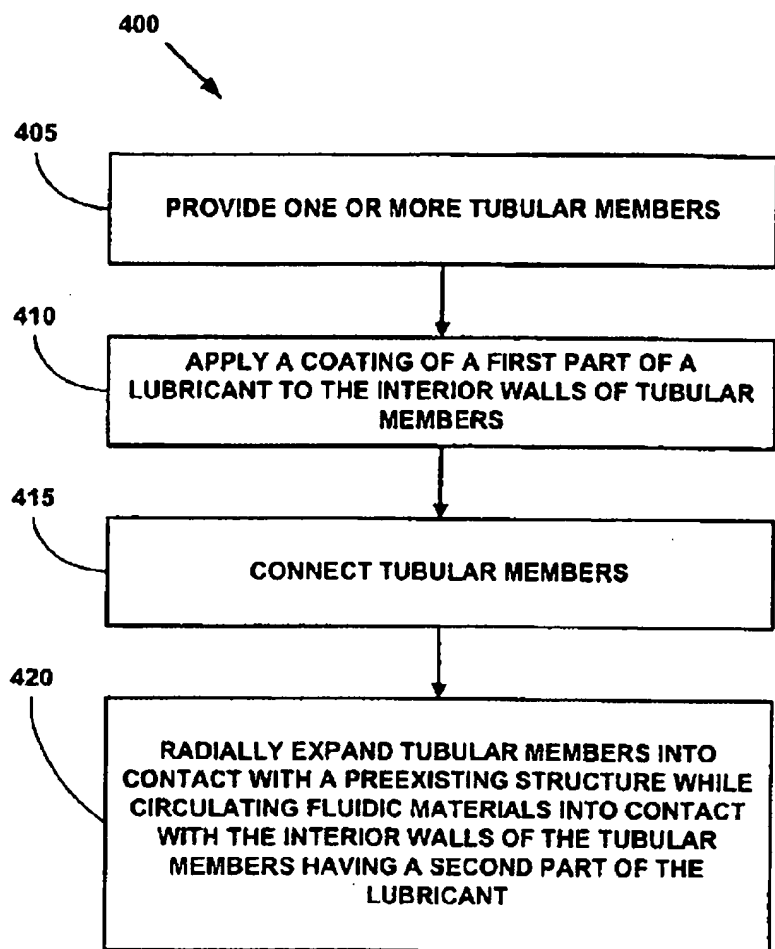


FIGURE 4

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